Novel Ultrasound Assessment of Dynamic Muscle

Completed Technology Project (2012 - 2012)

Project Introduction

Substantial research shows that skeletal muscle undergoes atrophy during spaceflight. Because maintenance of the musculoskeletal system is of crucial importance for mobility of astronauts during long-duration missions and upon return to 1-G, it is vital to learn as much as possible about muscle structure and function. Current reports on muscle atrophy following disuse or microgravity are based on study of a single anatomical cross-sectional area, a measurement that ignores more detailed changes in muscle structure. Significant insight into the relationship between muscle structure and function could be achieved by improving muscle imaging techniques. In particular, acquisition of ultrasound imaging during muscle contraction to monitor muscle dynamics could provide critical information regarding microgravity-induced strength loss.

Maintenance of the musculoskeletal system is of crucial importance for mobility of astronauts during long-duration missions and upon return to 1-G. However, substantial research shows that skeletal muscle undergoes atrophy during spaceflight. Reports on muscle atrophy are typically based on study of cross-sectional area, a measurement that ignores more detailed changes in muscle structure. Knowledge of the structure of skeletal muscle is key to understanding its function. Ultrasound imaging of muscle during contraction could provide important insight into the relationship between muscle structure and function. Importantly, the use of novel ultrasonographic techniques to evaluate dynamic muscle structure may provide critical information regarding the underlying mechanisms of microgravity-induced strength loss. Five subjects performed various passive and active contractions while ultrasound images of the rectus femoris were obtained. We demonstrated that acquisition of contracting muscle is obtainable using a high frequency ultrasound probe, and that the contracting muscle can be tracked with various algorithms using a custom Matlab program. This work was completed in September, 2012. Further investigations are needed to determine the most valid algorithm for tracking muscle, to assess the reliability of the muscle tracking technique, and to ascertain the association between torque and skeletal muscle strain. Tracking Algorithms in Matlab Program: Ultrasound images of tissue consist of a set of intensity forming 'speckles' that create patterns. If the ultrasound probe remains in the same position during a movement, the changes in the speckle patterns represent movements in the tissue. These movements can be directly and actively followed using speckle-tracking algorithms. Movements of the tissue over the course of an image sequence can then be quantified by monitoring changes in the position of the speckles. Five muscle tracking algorithms were tested with each algorithm outputting muscle strain throughout contractions. Analysis of Ultrasound Images with Matlab Program: On a typical ultrasound image (Figure), the cross sectional area of the muscle (rectus femoris) appears in the center of the image. Visual inspection confirmed that relative motion between the edges can be used to estimate the changes in length and thickness of the muscle. The muscle tracking algorithms

Project Image Novel Ultrasound Assessment of Dynamic Muscle

Table of Contents

Novel Ultrasound Assessment of Dynamic Muscle

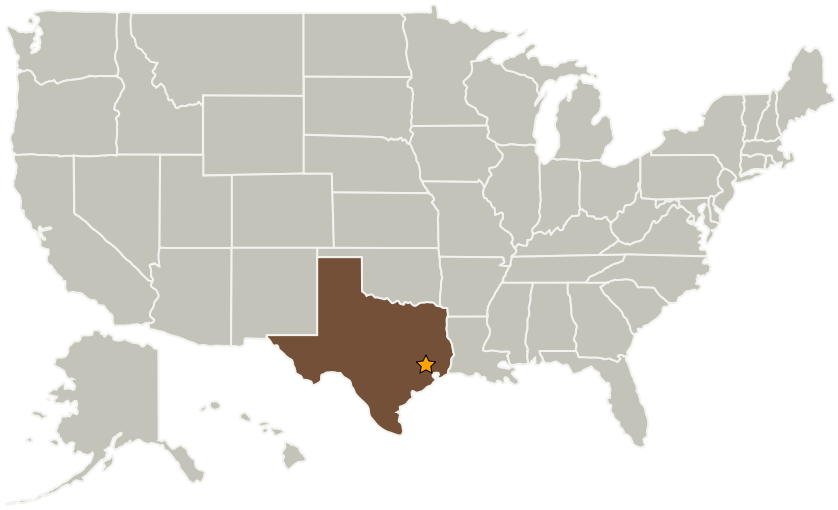
Completed Technology Project (2012 - 2012)

automatically tracked the change in position of each marker from the initial frame to subsequent frames for the duration of the contraction.

Anticipated Benefits

Ultrasound assessment of contracting skeletal muscle could allow crew members to monitor muscle function in-flight thus ensuring mission related tasks are completed safely and efficiently.

Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★Johnson Space Center(JSC)	Lead Organization	NASA Center	Houston, Texas
Universities Space Research Association(USRA)	Supporting Organization	R&D Center	Huntsville, Alabama

Primary U.S. Work Locations
Texas

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Center / Facility:

Johnson Space Center (JSC)

Responsible Program:

Center Innovation Fund: JSC CIF

Project Management

Program Director:

Michael R Lapointe

Program Manager:

Carlos H Westhelle

Project Manager:

Donald J Stilwell

Principal Investigator:

Jessica M Scott

Novel Ultrasound Assessment of Dynamic Muscle

Completed Technology Project (2012 - 2012)

Images

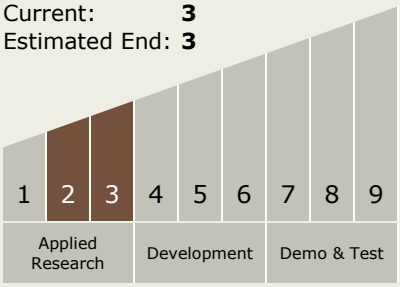
12418-1375987737359.jpg
Project Image Novel Ultrasound Assessment of Dynamic Muscle
(https://techport.nasa.gov/image/2184)

Links

NTR 1
(no url provided)

Technology Maturity (TRL)

Start: **2**
Current: **3**
Estimated End: **3**



Technology Areas

Primary:

- TX06 Human Health, Life Support, and Habitation Systems
  - TX06.3 Human Health and Performance
    - TX06.3.3 Behavioral Health and Performance